

Estimated Exposure Risks from Carcinogenic Nitrosamines in Urban Airborne Particulate Matter

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Introduction

Inhalation of particulate matter less than 2.5 µm in diameter, termed PM_{2.5}, has particularly adverse effects on human health as these fine particles can reach regions of the respiratory tract where gaseous exchange occurs. Within PM_{2.5} exist a range of organic nitrogen (ON) compounds which are often difficult to characterise due to various complexities; they span a wide range of volatilities and polarities, originate from both biogenic and anthropogenic sources, and can undergo many biological and photochemical transformations. Nitrosamines are a particular class of ON compounds that have been classified by the International Agency for Research on Cancer (IARC) as extremely potent carcinogens.¹ The first time-resolved measurements of nitrosamines in ambient air have been made, allowing for a direct comparison with recommended guideline levels and an estimation of the human cancer risk from exposure *via* inhalation.

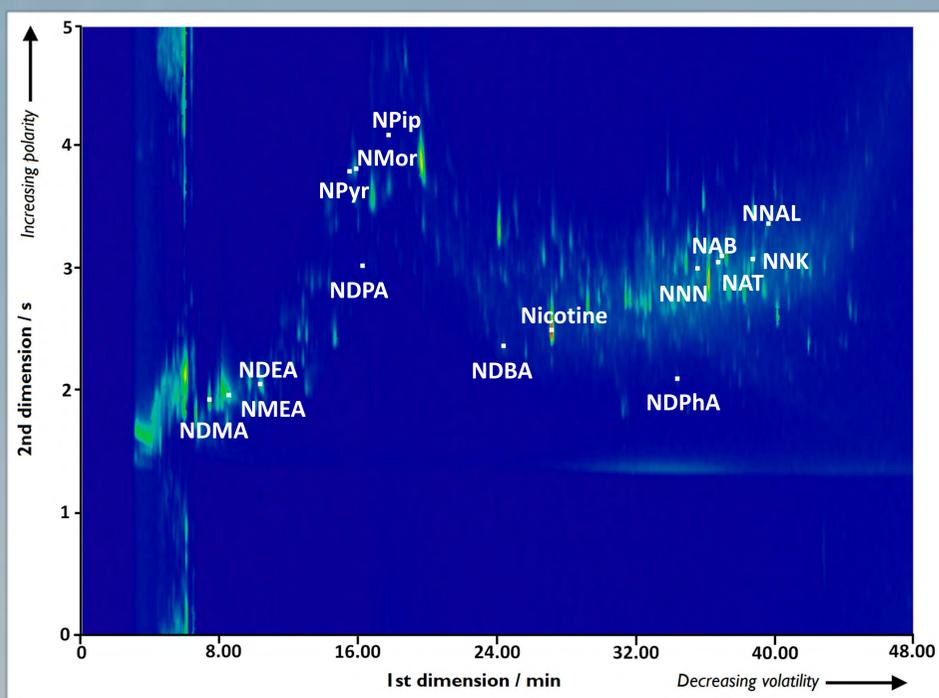
Sampling



- PM_{2.5} samples collected as part of Clean Air for London (ClearLo) project
- Urban background site in North Kensington, London (51° 31' 16" North, 0° 12' 48" West)
- Two collection periods (January and August 2012)
- Accelerated Solvent Extraction
- Comprehensive 2D gas chromatography-nitrogen chemiluminescence detection (GC×GC-NCD)

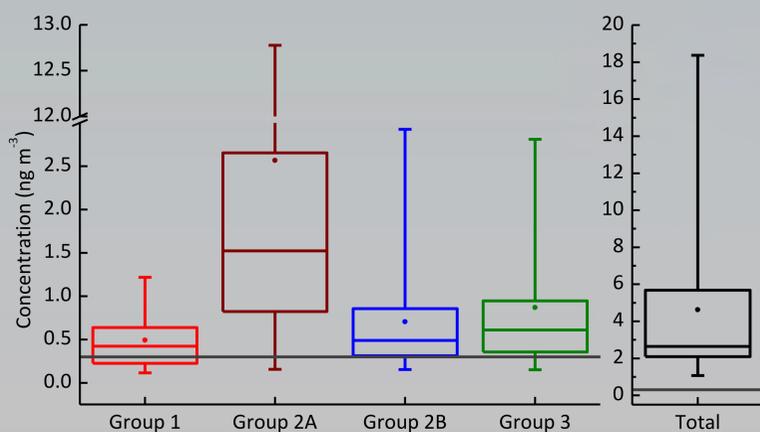
Measurements

As shown in the 2D chromatogram below, the GC×GC-NCD was capable of separating over 700 ON compounds. This allowed for the determination of daily variability in nicotine, and 8 non-specific and 4 tobacco-specific nitrosamines in ambient PM from central London over two periods in winter and summer.



Exposure via Inhalation

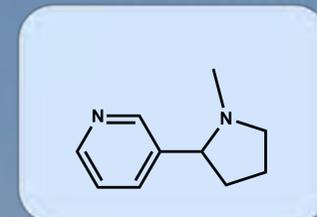
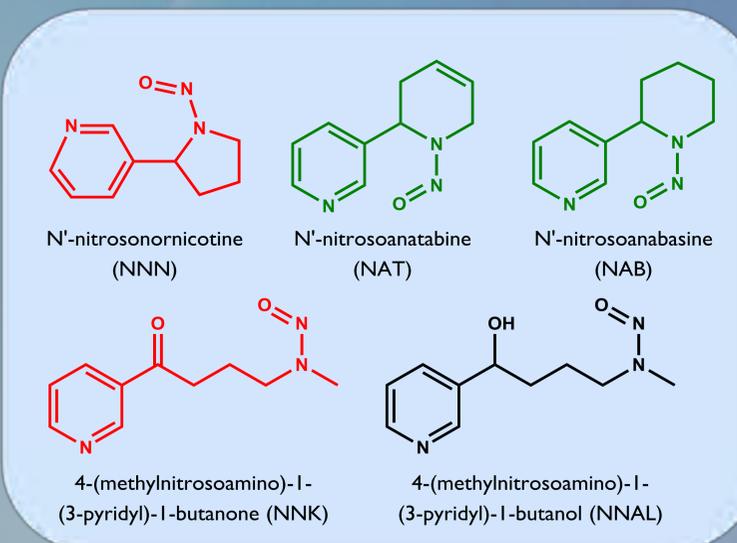
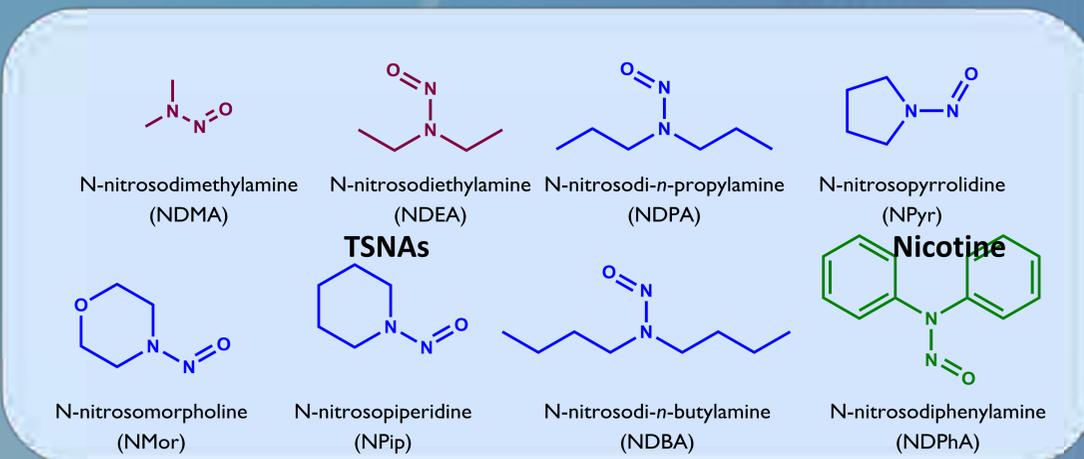
Box-plot representations of measured nitrosamine concentrations according to their IARC classifications. In 2011, the Norwegian Institute of Public Health (NIPH) recommended that the total concentration of nitrosamines in ambient air should not exceed 0.3 ng m⁻³.² Measurements show that the average nitrosamine concentration exceeded 0.3 ng m⁻³ across all of the group classifications, with a total average concentration of 4.6 ng m⁻³. Group 2A carcinogens were the most prevalent; the maximum concentration recorded was 12.8 ng m⁻³.



Measured nitrosamine concentrations in summer 2012. The box plot represents the 25th and 75th percentiles, and the bottom and top lines indicate minimum and maximum concentrations. The circle is average concentration, and the horizontal line inside the box represents median concentration. The horizontal grey line at 0.3 ng m⁻³ represents the NIPH recommended level.

Nitrosamines

Non-specific nitrosamines (N-nitrosamines) are emitted to the atmosphere directly *e.g.* from tobacco smoke, cooking or vehicle emissions; alternatively they are formed in the atmosphere through oxidation of their precursor amines. Nicotine is the most abundant organic compound emitted during smoking and can oxidise to form a class of special interest nitrosamines, tobacco-specific nitrosamines (TSNAs).

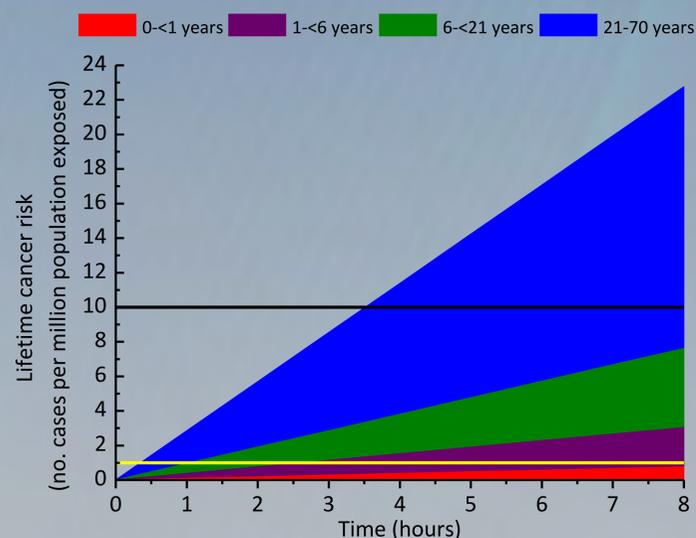


IARC classifications

- Group 1: definite carcinogen
- Group 2A: probable carcinogen
- Group 2B: possible carcinogen
- Group 3: not classifiable

Estimated Cancer Risk

The lifetime cancer risk associated with inhalation of nitrosamines in ambient air was estimated. The risk is expressed as the number of excess cases per million population exposed. For adults, the minimal cancer risk (10 excess cancer cases per 1 million people) is exceeded after 4 hours of exposure to outdoor ambient air. If an adult is exposed to these nitrosamine levels 24 hours per day, the risk is estimated to be 68 cancer cases per million population exposed.



The current EU guideline for benzo(a)pyrene, which is used as an indicator for carcinogenic polycyclic aromatic hydrocarbons, is 1 ng m⁻³, or 100 excess cancer cases per million population exposed. However, the UK air quality panel have recommended that this level is reduced to 25 cases. It is clear that ambient nitrosamine concentrations, at least in London, are currently at levels likely to pose a significant long term cancer risk.

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References

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